Space Weather Technical Forecast

Issued on Sunday 9 February 2025 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares (R1-R2; Minor-Moderate radio blackouts) likely throughout. G1/Minor storms likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with an M-class flare, peaking at M2.0 at 08/0927 UTC from AR3981 in the northwest quadrant.

There are ten active regions on the Earth-facing disc. The majority of interest is in the northwest with a cluster of entwined regions containing AR3976, AR3978, AR3981 and AR3984. Of these, AR3981 remains the largest and most complex region on the visible disc, the two delta regions in the intermediate portion are no longer evident. AR3981, and the rest of the spots in the northwest have show signs of decay in recent imagery, most significantly from AR3978, AR3984 and AR3981 with their intermediate spots fading. The spots within this northwestern cluster are close together and it is difficult to define the exact boundaries of each region. As such they are magnetically interconnected, with interaction between the various regions. The remaining regions on the disc are small and simple at present.

No significant coronal mass ejection (CME) were evident in available coronagraph imagery

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, remained at slow ambient levels, around 350km/s with a slight decline noted. The density was near average. The Interplanetary Magnetic Field, Bt, was initially weak, around 5nT with a rising trend to become moderate by 08/0800 UTC, then peaking at 14nT at 08/2114 UTC. The north-south component, Bz, was rather variable at Weak to Moderate levels between -9/+12nT. The phi angle was positive (away from the Sun). Geomagnetic activity was mainly Quiet (Kp 0-2) with a brief Unsettled (Kp3) interval between 08/0600-08/0900 UTC.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 remained at background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at mostly background to moderate levels. The associated 24-hour fluence persisted below the Active threshold on a generally flat trend, recording 1.86e6 integrated pfu at 00/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is expected to continue, with a slight chance of an X-class flare, primarily from the cluster of regions in the northwest, and the greatest risk is from AR3981, especially during the next couple of days, before it rotates over the northwest limb.

Solar Wind / Geomagnetic Activity: There is a slight chance of two glancing coronal mass ejections during Days 2 or 3 10-11 Feb. Solar winds are currently slow-ambient. The next feature is a High Speed Stream related to CH13/- which is expected to arrive during Day 1 (09 Feb), perhaps more likely during the second half of the day, and CH HSS persisting through much of the remainder of the period. Solar winds are expected to become elevated to strong.

Predominantly Quiet (Kp 0-2) geomagnetic activity is expected. Activity is then expected to increase during days 1 and 2 (09/10 Feb) due to the HSS from CH13, perhaps with some limited CME influence, becoming Active to G1/Minor storm (Kp 4-5) with a slight chance of G2/Moderate storm intervals (Kp 6). This enhanced geomagentic activity likely continuing through the remaining days with Active to G1/Minor storms, and potential connection to further fast winds related to CH14/-.

Energetic Particles / Solar Radiation: There is a slight chance of S1/Minor radiation storm events as the cluster of sunspots in the northwest are now in a good position to connect with Earth, should there be further large flares. High energy electron flux observed at GOES16 is expected to be mostly at background levels, with a probable rising trend on Days 3 and 4 (11-12 Feb). The corresponding 24 hour fluence is likely to persist below the Active threshold.

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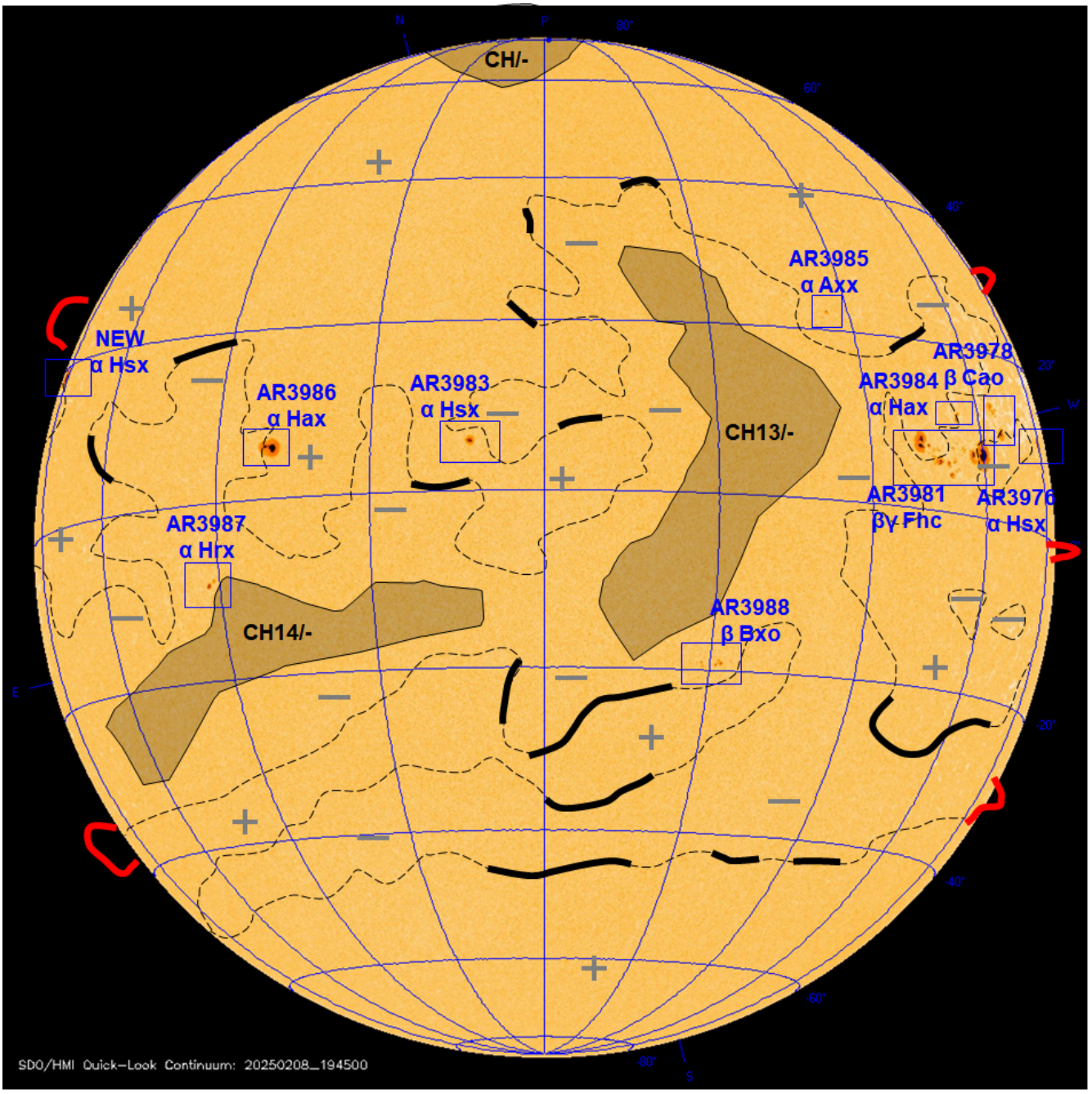
Figure 1: Solar Synoptic Map valid 08/20000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There is a slight chance of up to two glancing blows from faint CMEs associated with two M7 flares on 06/07 Feb, which may arrive at Earth late on Day 2 (10 Feb) and into the early hours of Day 3 (11 Feb). A partial halo CME was present in coronagraph imagery in the early hours of 08 Feb, this has good confidence that its far-sided and isn't expected to produce any impacts at Earth.

Solar winds are currently slow-ambient, around 350km/s. The next recurrent feature, the High Speed Stream from CH13/-, is expected to arrive during Day 1 (09 Feb), perhaps more likely during the second half of the day, lasting beyond Day 2 (10 Feb). This feature appears to be larger and more intense compared to the previous rotation, when speeds reached around 450 km/s. On this rotation solar winds are expected to become elevated to potentially strong at 500-600 km/s, in line with MOSWOC Enlil expectations. However, Enlil is now too early in its onset of the HSS arrival at Earth. This is expected to be shortly followed by a connection to a HSS from CH14/-, again a recurring feature with solar winds becoming Elevated to Strong.

Quiet to Unsettled (Kp 0-2) geomagnetic activity is likely to increase from Day 1 (09 Feb) due to a connection to the HSS from CH13, becoming Active to G1/Minor storm (Kp4/5) with a slight chance of G2/Moderate storm intervals (Kp6). Through the rest of the guidance period activity likely continuing at Active to G1/Minor storm levels, with the combined risk of the CME arrival and potential connection to a HSS from CH14.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	50	60	50
Strong	G3	No	5	5	10	5
Severe	G4	No	1	1	1	0
Extreme	G5	No	1	1	1	0

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
07/0200	Partial	AR3981	NW	300	10/2100 +/-12 hours	Low confidence.
07/2100	Partial	AR3981	NW	300	11/0000 +/-12 hours	Low confidence.

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Figure 2: Latest run of the Met Office ENLIL model showing the imminent arrival of a HSS related to CH13/-. ENLIL is too early with this particular feature.

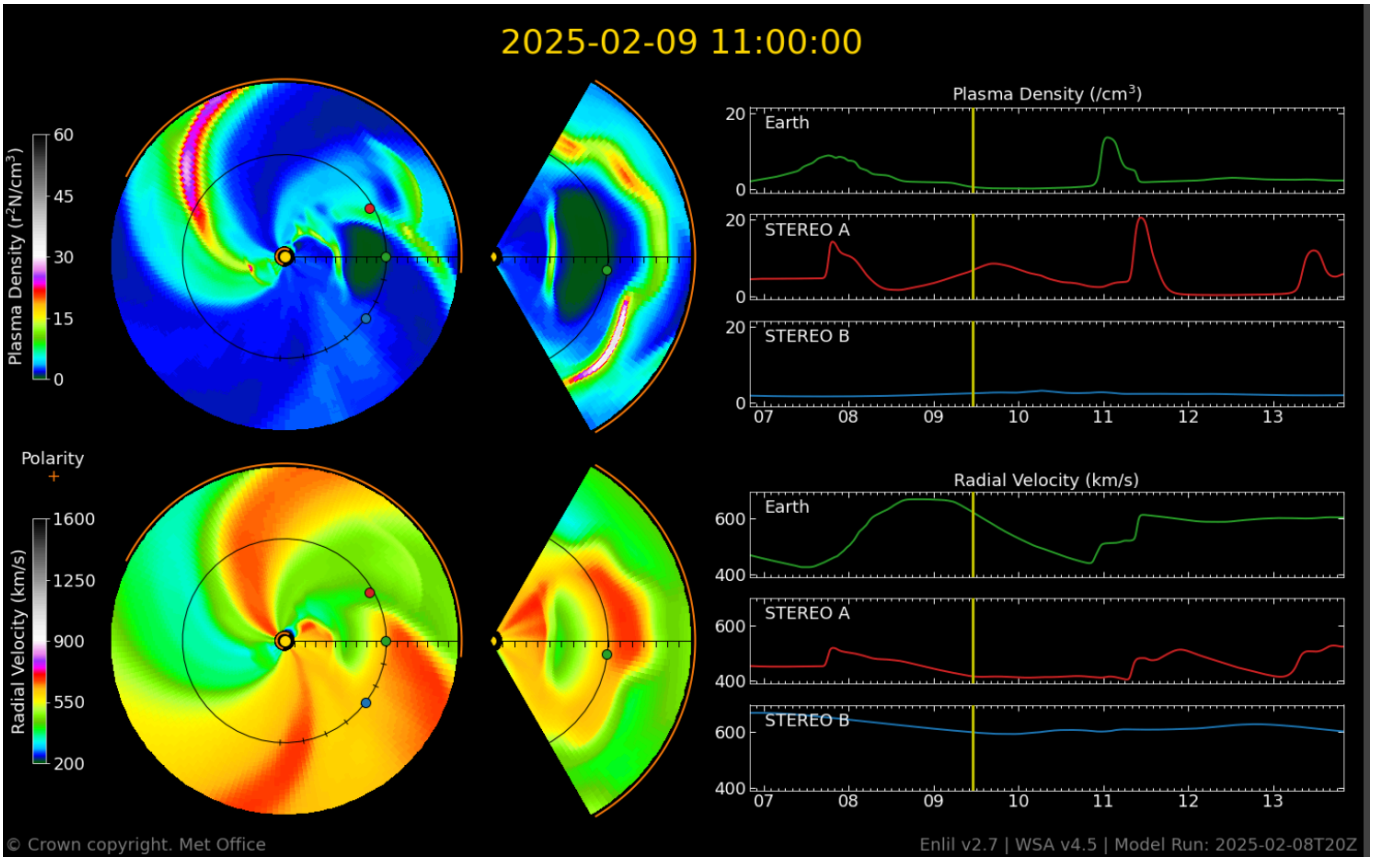
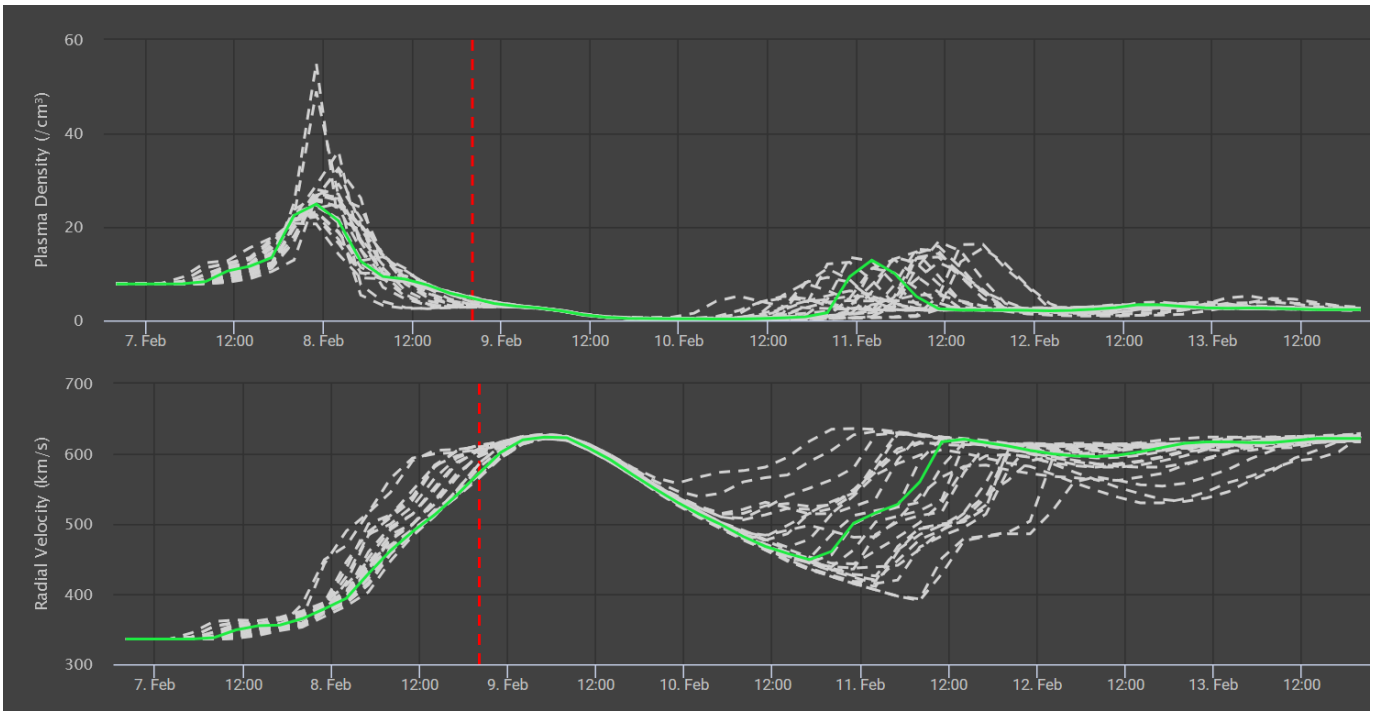


Figure 3: Latest run of the Met Office ENLIL model showing complex CME arrivals on 10 and 11 Feb.



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Radio Blackouts - X-Ray Flares

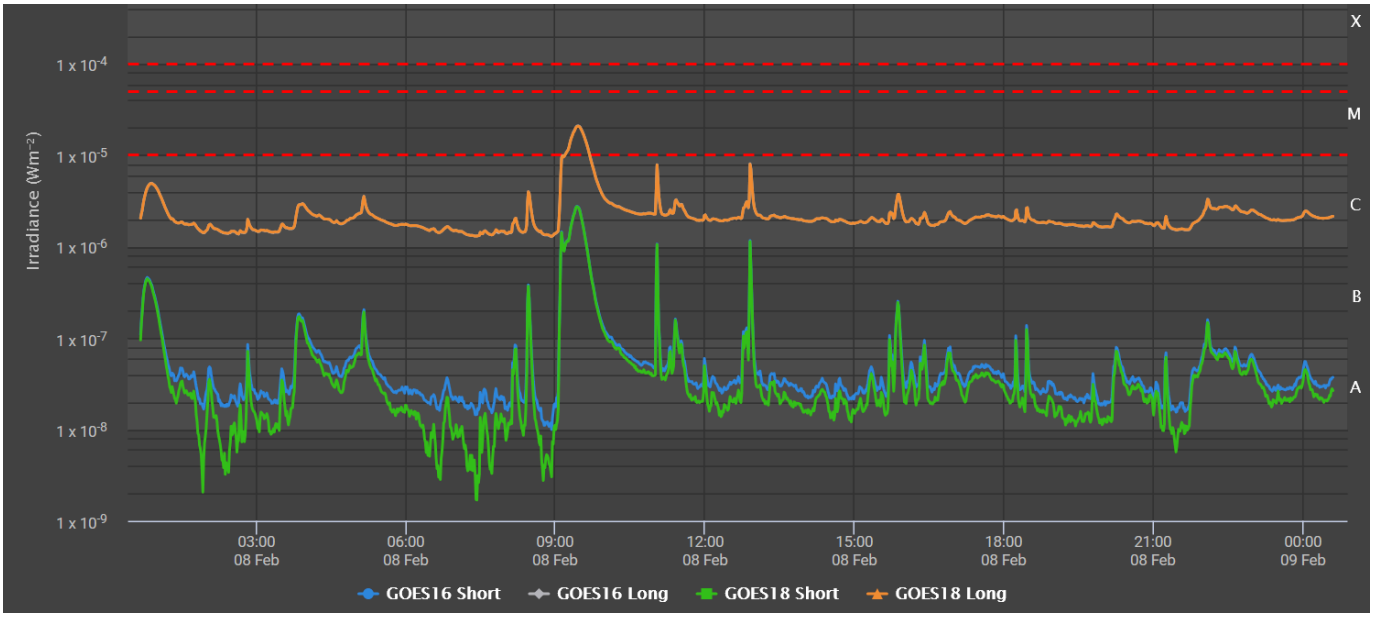
There are ten active regions on the Earth-facing disc. Most interest remains in the northwest quadrant, with a cluster of entwined regions containing AR3976, AR3978, AR3981 and AR3984.These four regions continue to mostly show slow decay in recent hours. The largest and most complex region is AR3981 with the loss of its remaining delta spot in the intermediate portion. The other regions within this cluster are close together and rather ill-defined with respect to their boundaries and appear magnetically interconnected. Remaining regions on the disc are relatively small and simple. A new unnumbered region is roating across the northeast limb.

Solar activity is moderate with an M-class flare reaching M2.0 at 08/0927 UTC from AR3981. Otherwise a few high C-class flares originating from the cluster in the northwest. Further M-class flares are likely, with a slight chance of an isolated X-class flare.

While AR3981 is likely to rotate of the western limb by the end of Day 2 (10 Feb), SDO/AIA 171 imagery shows notable looping around the eastern limb and combined with far-sided data suggests several complex regions are soon to appear. As a result the forecast probabilities of significant flares, in the table below, remain relatively steady throughout.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	10	10	20	20

Figure 4: X-ray flux at GEO from GOES data with M-class flare around 18 hours ago.



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Solar Radiation Storms (High Energy Protons)

The northwestern cluster of sunspots, including AR3981, is in a favourable position to connect with Earth and produce an increase in proton flux following any large flares. That said, none of the more notable flares have so far proven proton-rich, therefore the overall risk is remained at a slight chance of reaching above the S1/Minor radiation storm threshold throughout the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at background to moderate levels. The imminent arrival of the High Speed stream (HSS) related to CH13/-, is likely to give an eventual signficant response in charging of the Van-Allen belts but this may not start until the end of the guidance period. Possible CME arrivals in the interim complicate this picture, but overall mostly background electron flux is expected until later in the period when high levels are more likely at the diurnal peak.

The corresponding 24-hour fluence is expected to persist below the Active threshold through much of this guidance period, with a rising trend through Days 3 and 4 (11-12 Feb). MOSWOC REFM output shows levels below Active. However this may be underperforming later in the period given the more marked appearance of CH13/- and probabilities of a breach are raised for the fluence alert to be activated by Day 4 (12 Feb).

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	10	40
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	5

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Figure 5: High energy electron flux at GEO and MOSWOC REFM output.

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